

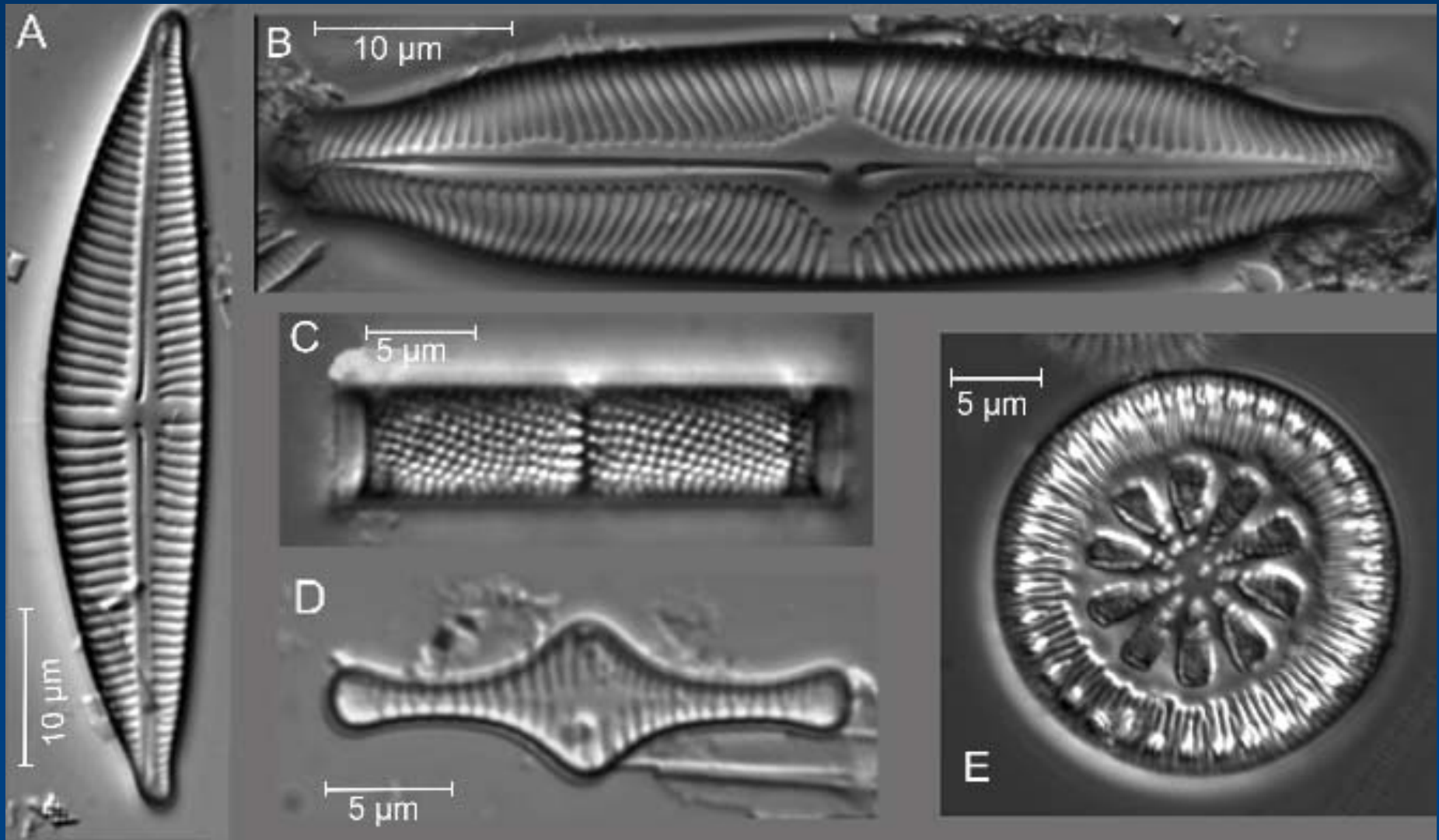
Diatom Communities Past and Present – and Their Relevance to a National Lake Assessment Program

Donald Charles
Patrick Center for Environmental Research
Academy of Natural Sciences
Philadelphia, PA

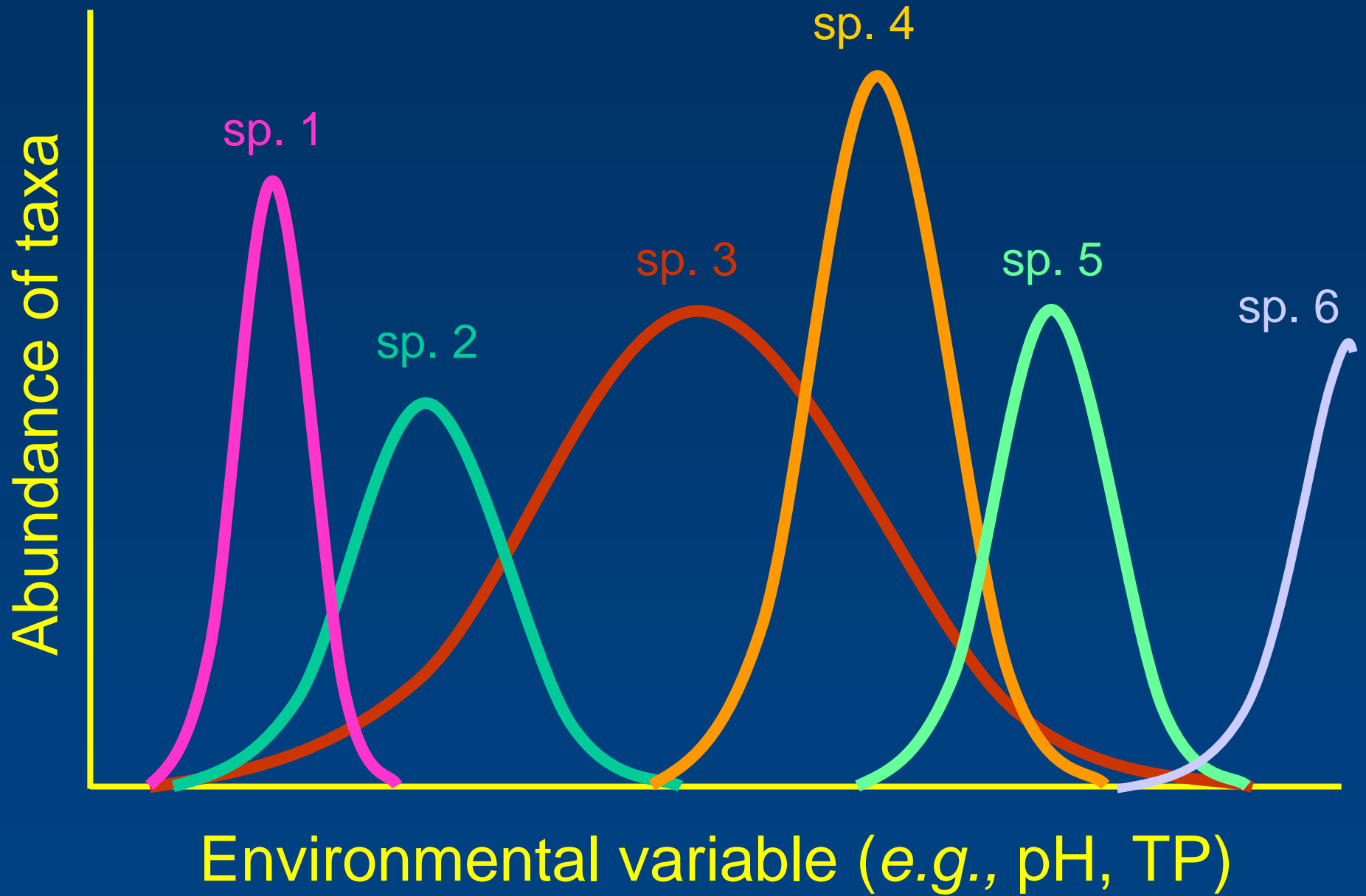
Questions / Outline

- What is the diatom / paleo method? What can we learn?
- What lake-condition questions can be addressed? How quantified?
- How do you do the work - field, lab, modeling?
- What are some examples?
- How could a diatom / paleo component be implemented?

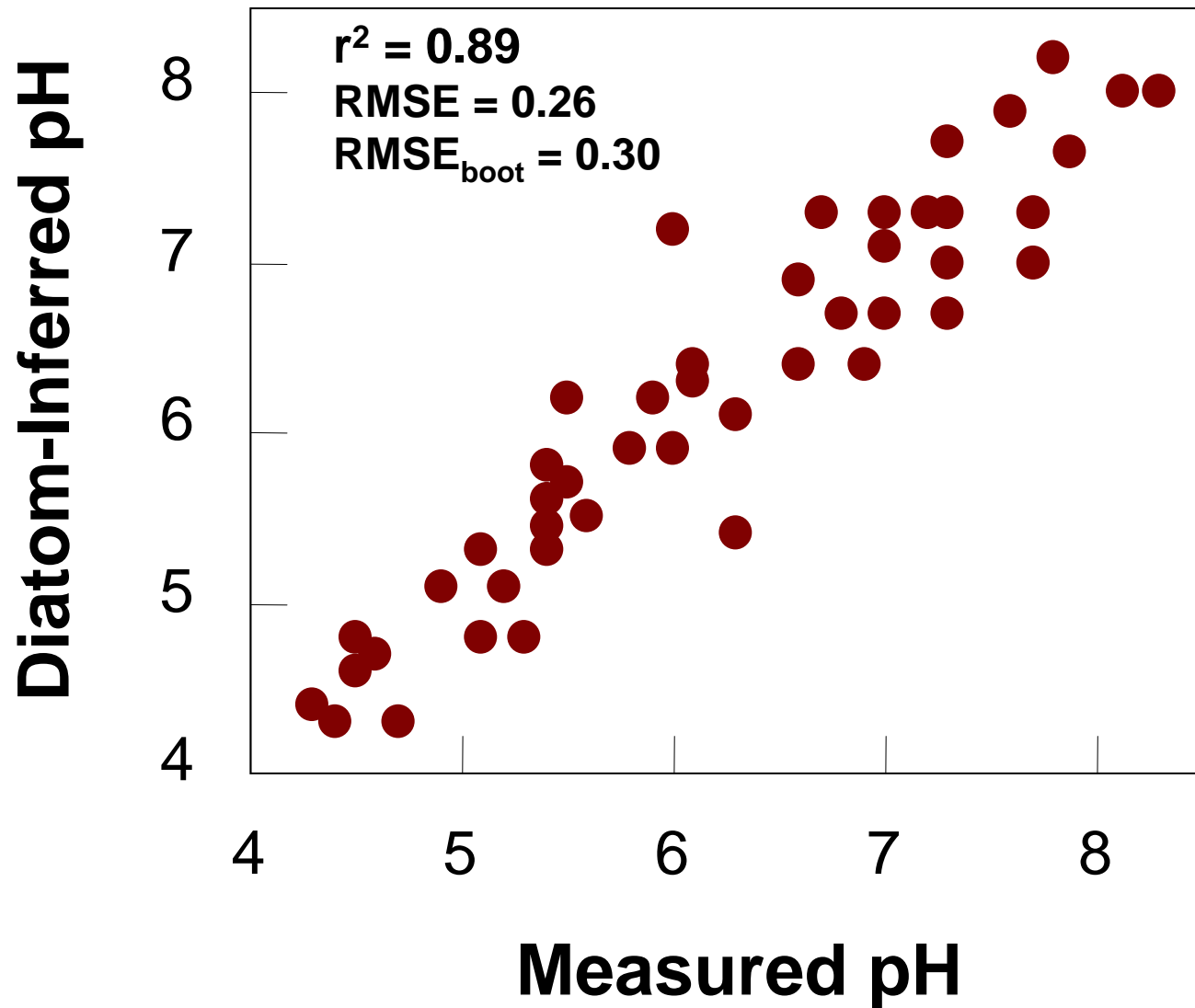
Freshwater diatoms



Photos: K. Laird and B. Cumming; Fig. 5.4 in Smol (2002)



Diatom Inference Model for pH - Adirondacks

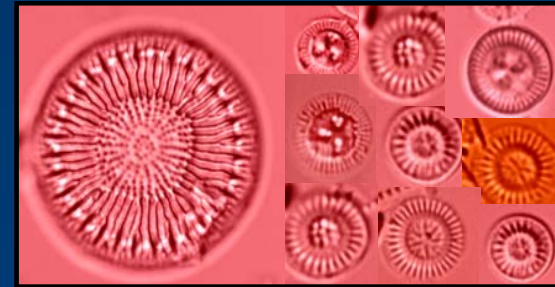


“Top-Bottom” Sediment Sampling Approach



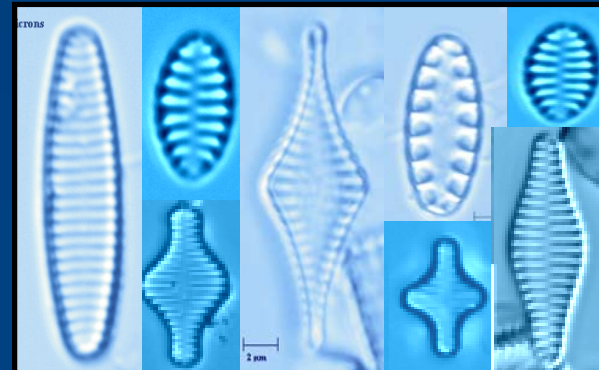
TOP

Deposited in recent lake environment



BOTTOM

Deposited in pre-industrial lake environment



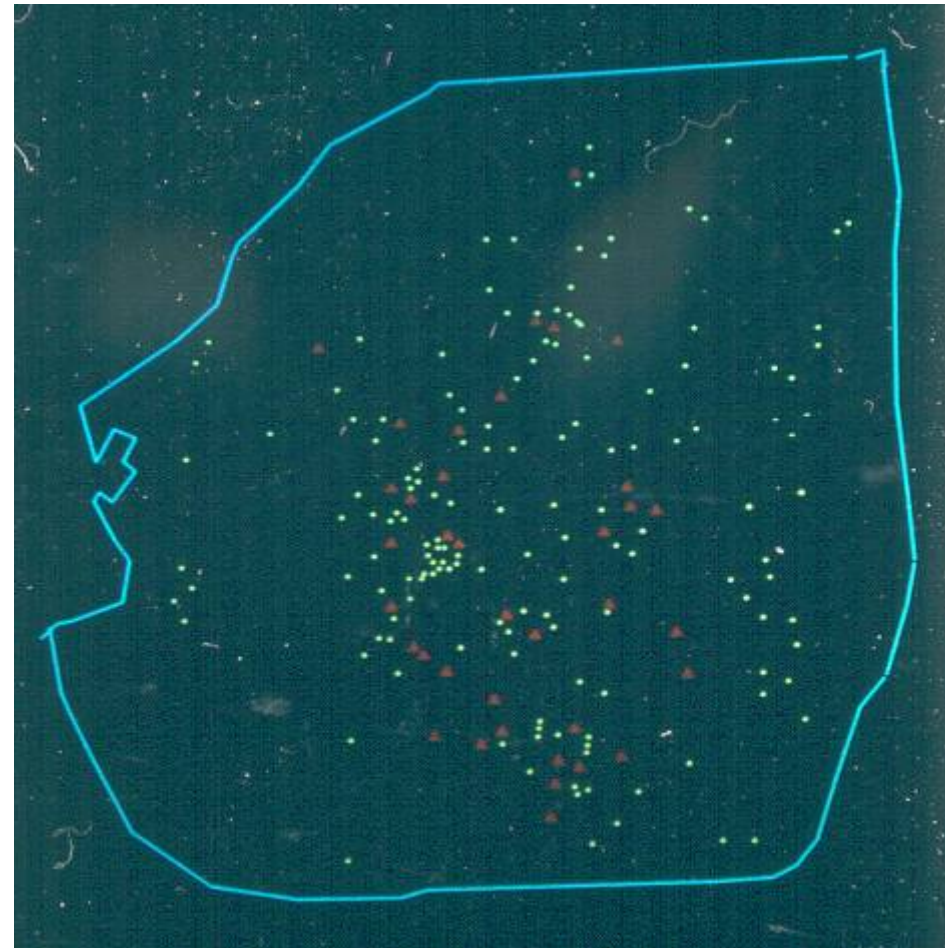
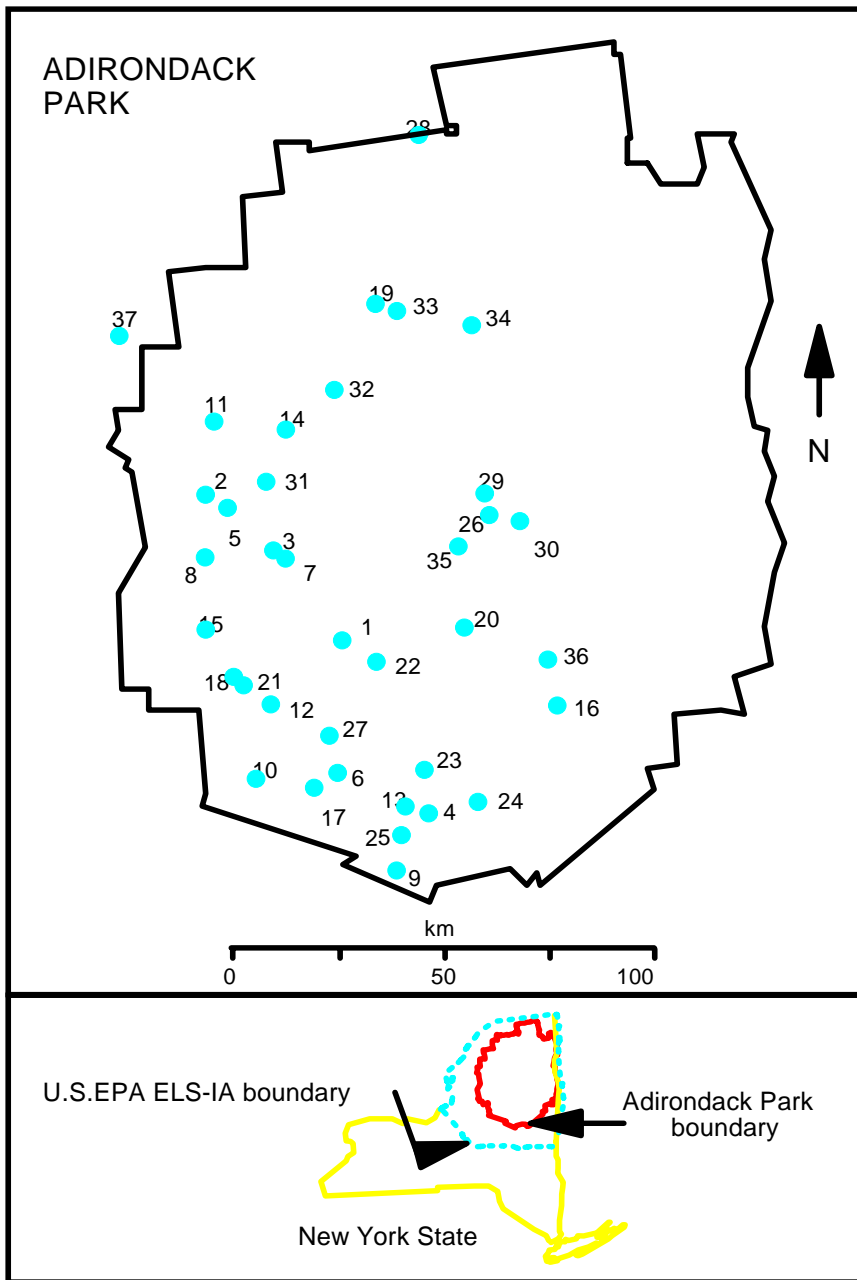
J. Smol

Lake survey questions that can be addressed

- What was the pre-disturbance / reference condition?
- What is the range of natural variability?
- Have conditions changed?
- How? How much? How fast? When?
- What is the cause of the change?
- How much improvement can be expected?

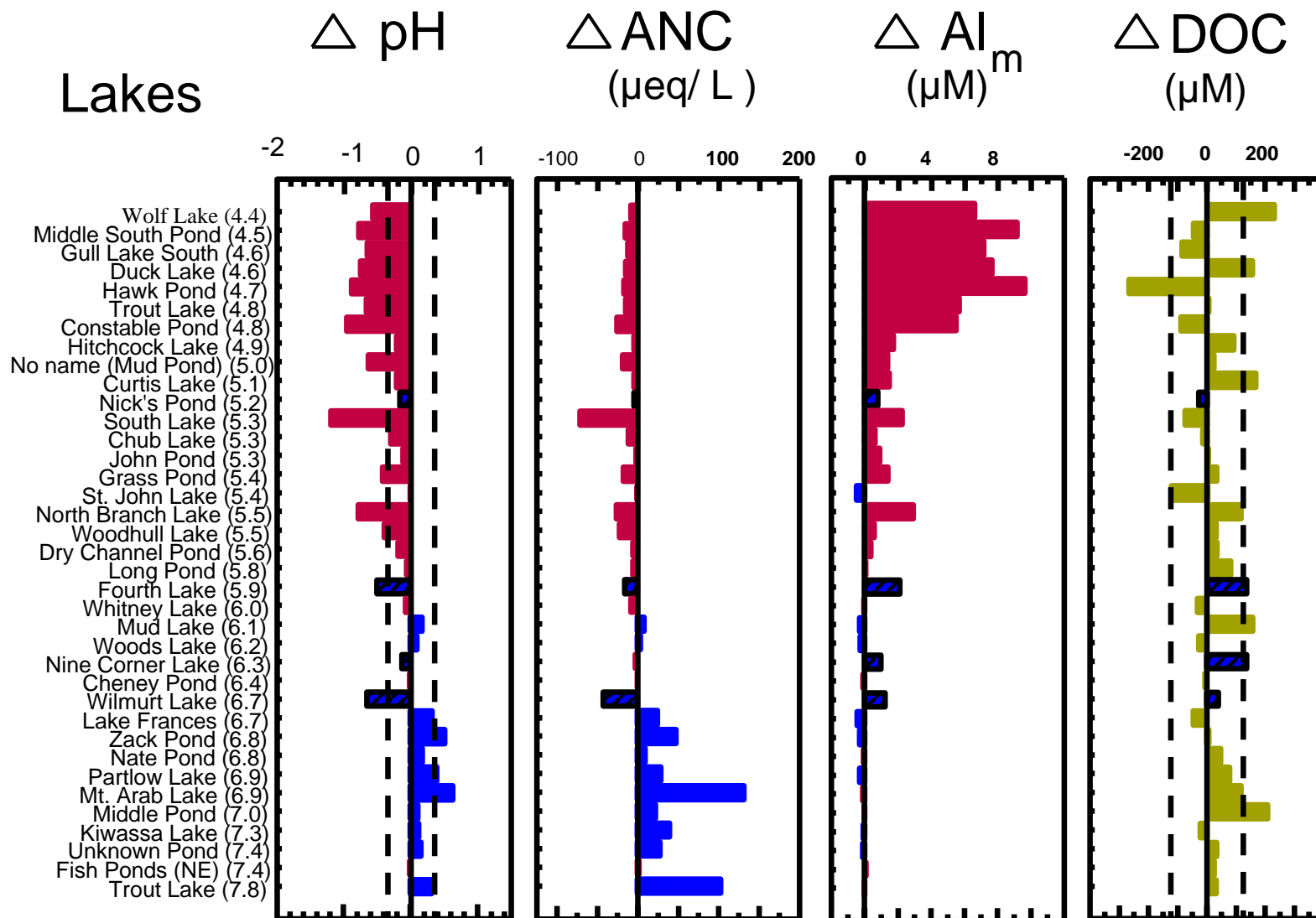
Paleoecological Investigation of Recent Lake Acidification (PIRLA II) NAPAP / AERP

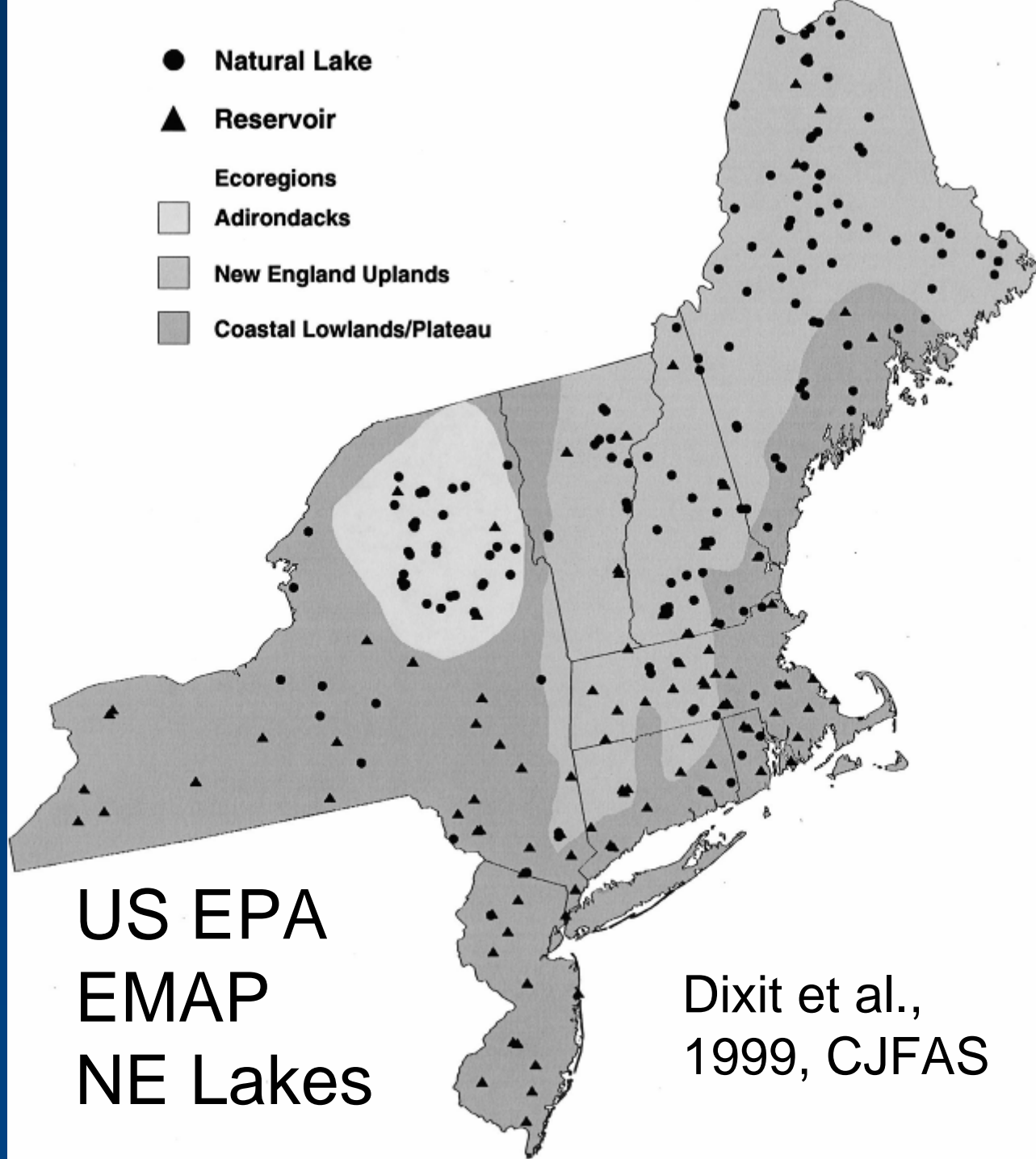
Adirondack Park, NY

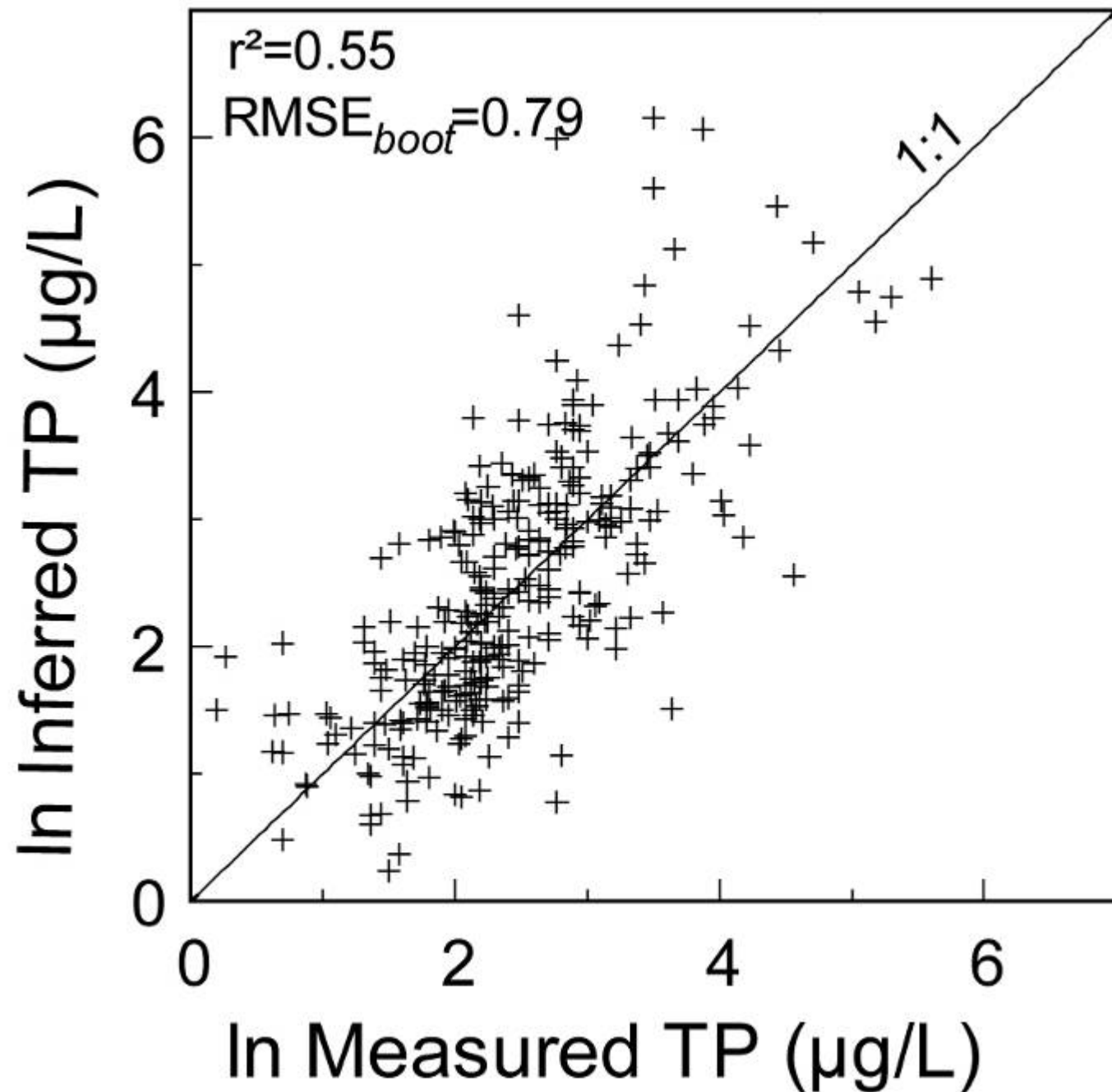


Cumming et al., 1992, CJPAS

Arranged according to increasing present-day pH

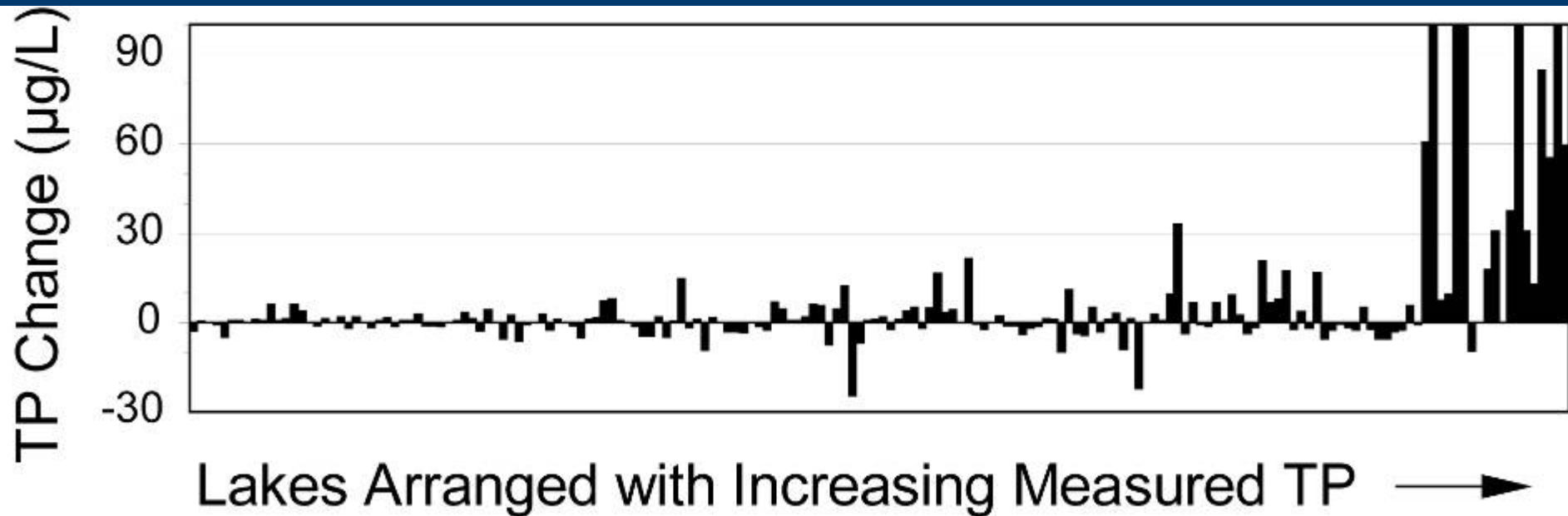






EMAP – Northeast Lakes

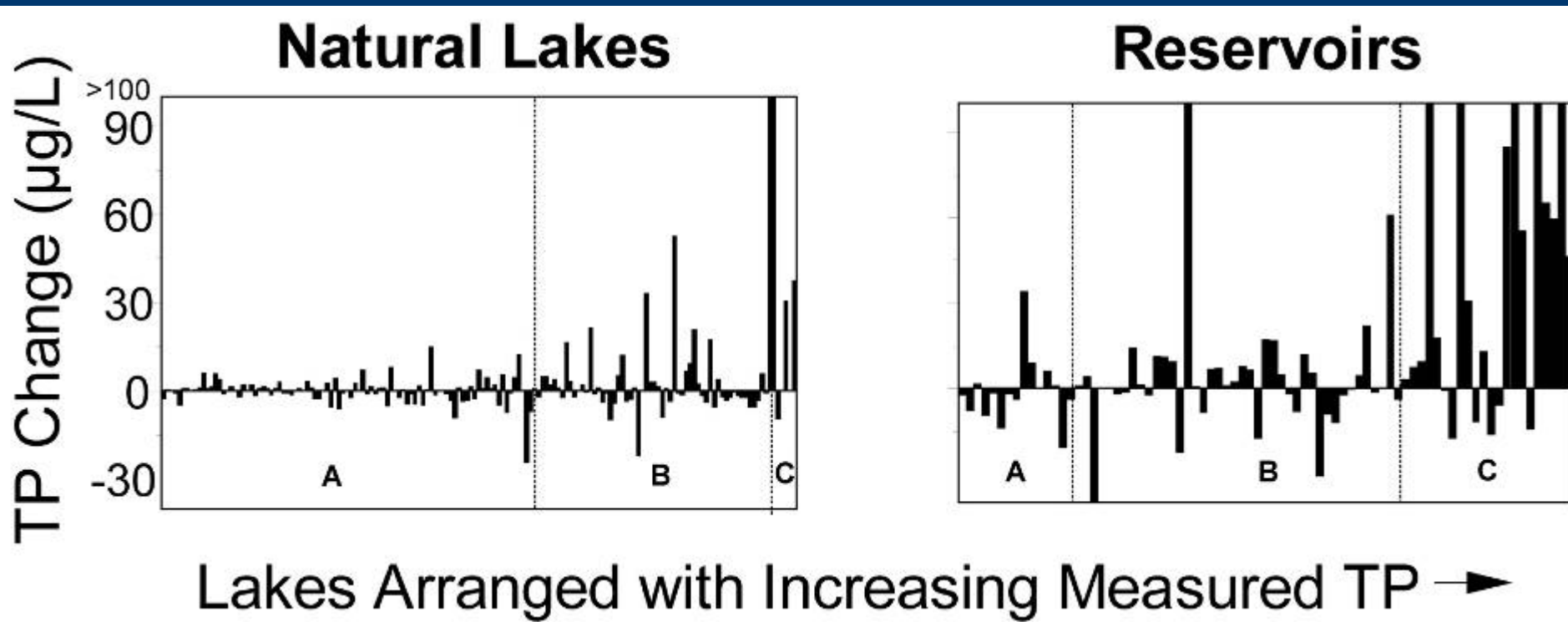
Diatom inferred TP change



Dixit et al. 1999, CJFAS

EMAP – Northeast Lakes

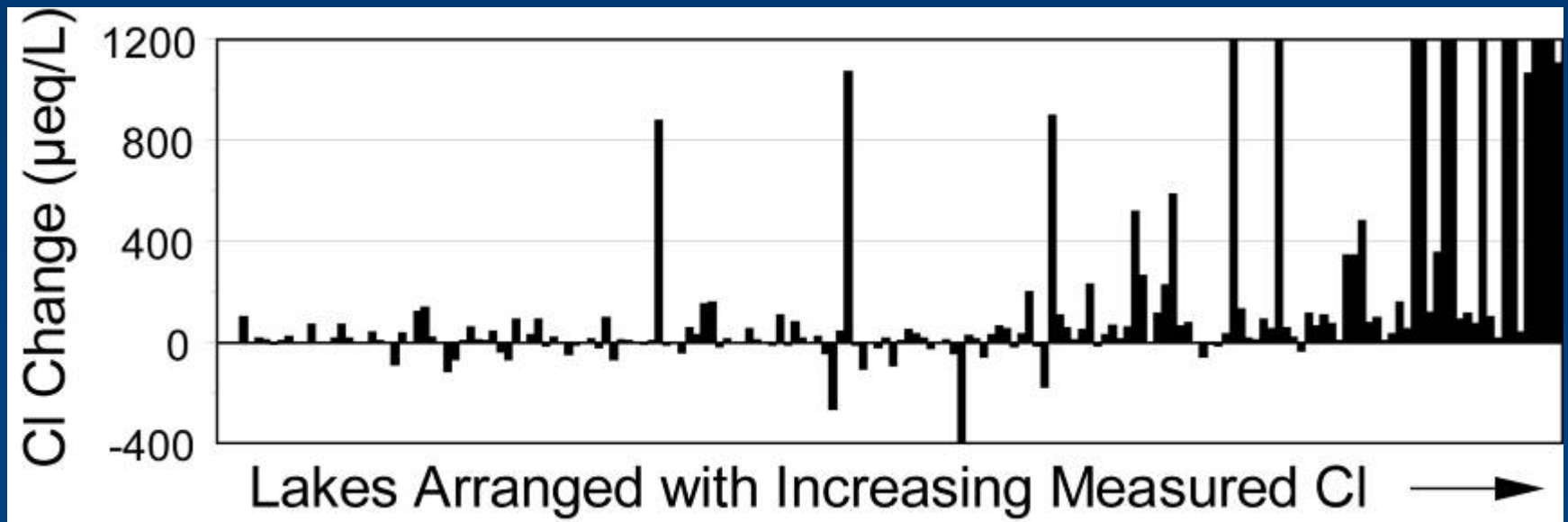
Diatom inferred TP change



Dixit et al. 1999, CJFAS

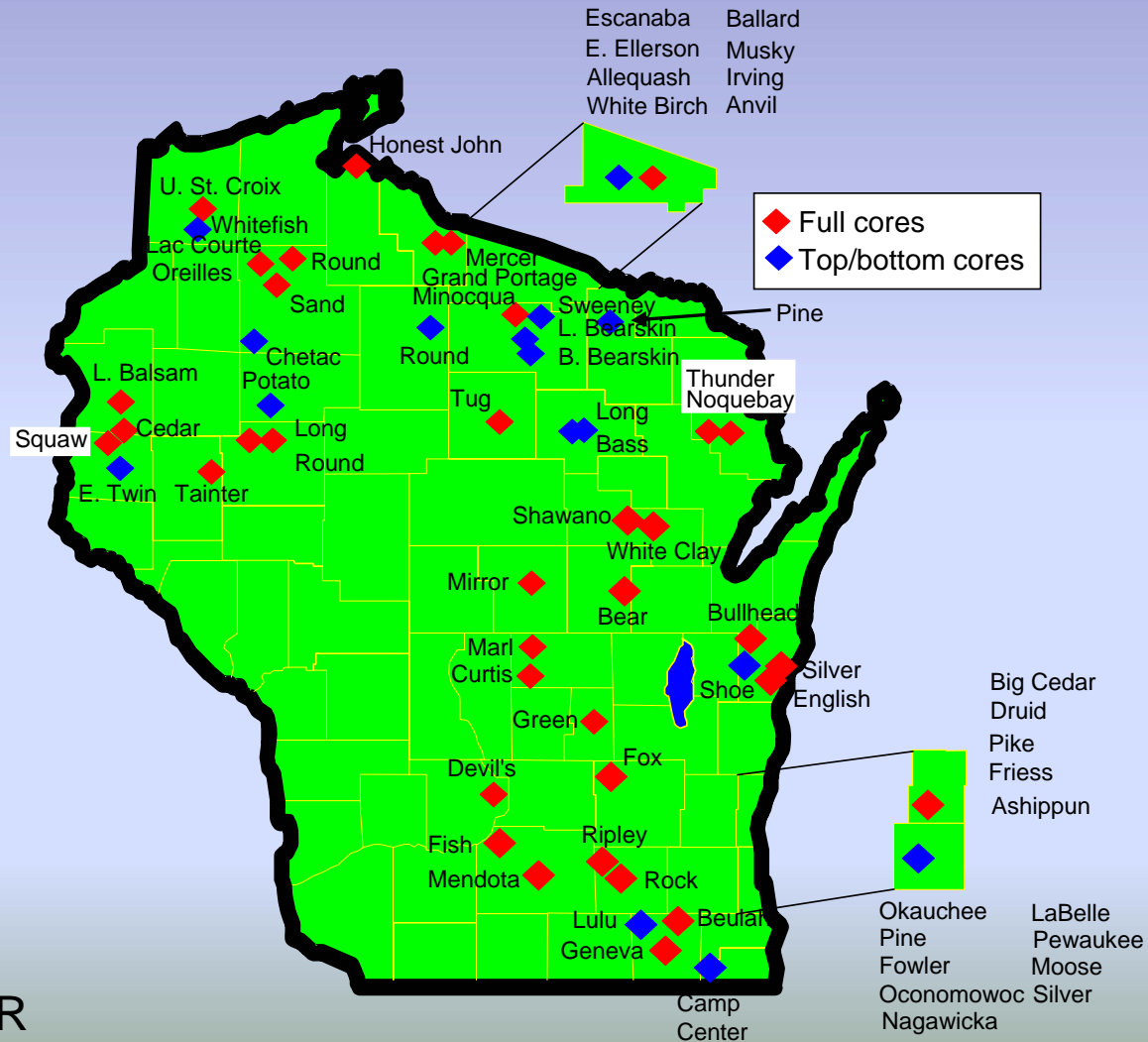
EMAP – Northeast Lakes

Diatom inferred Cl change



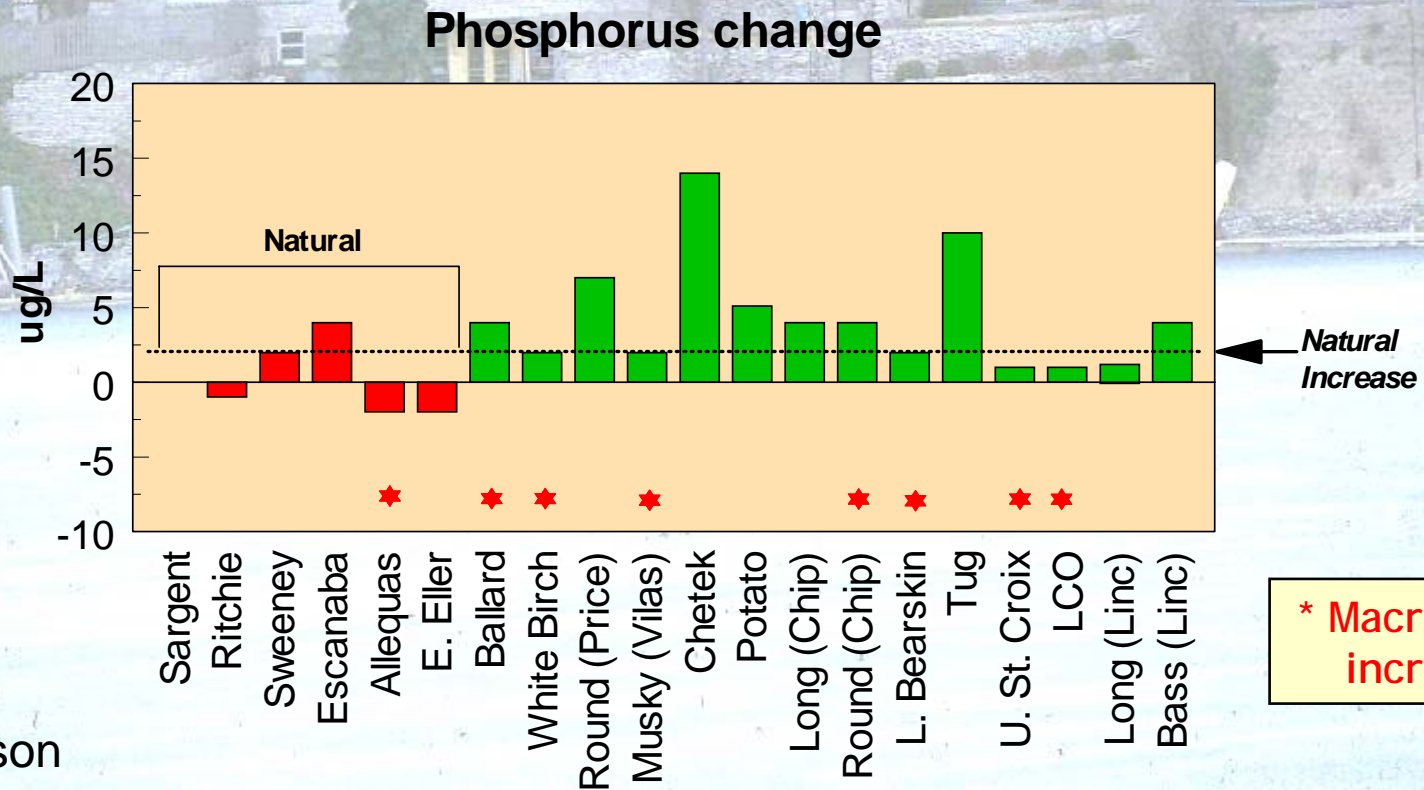
Dixit et al. 1999, CJFAS

CORED LAKES



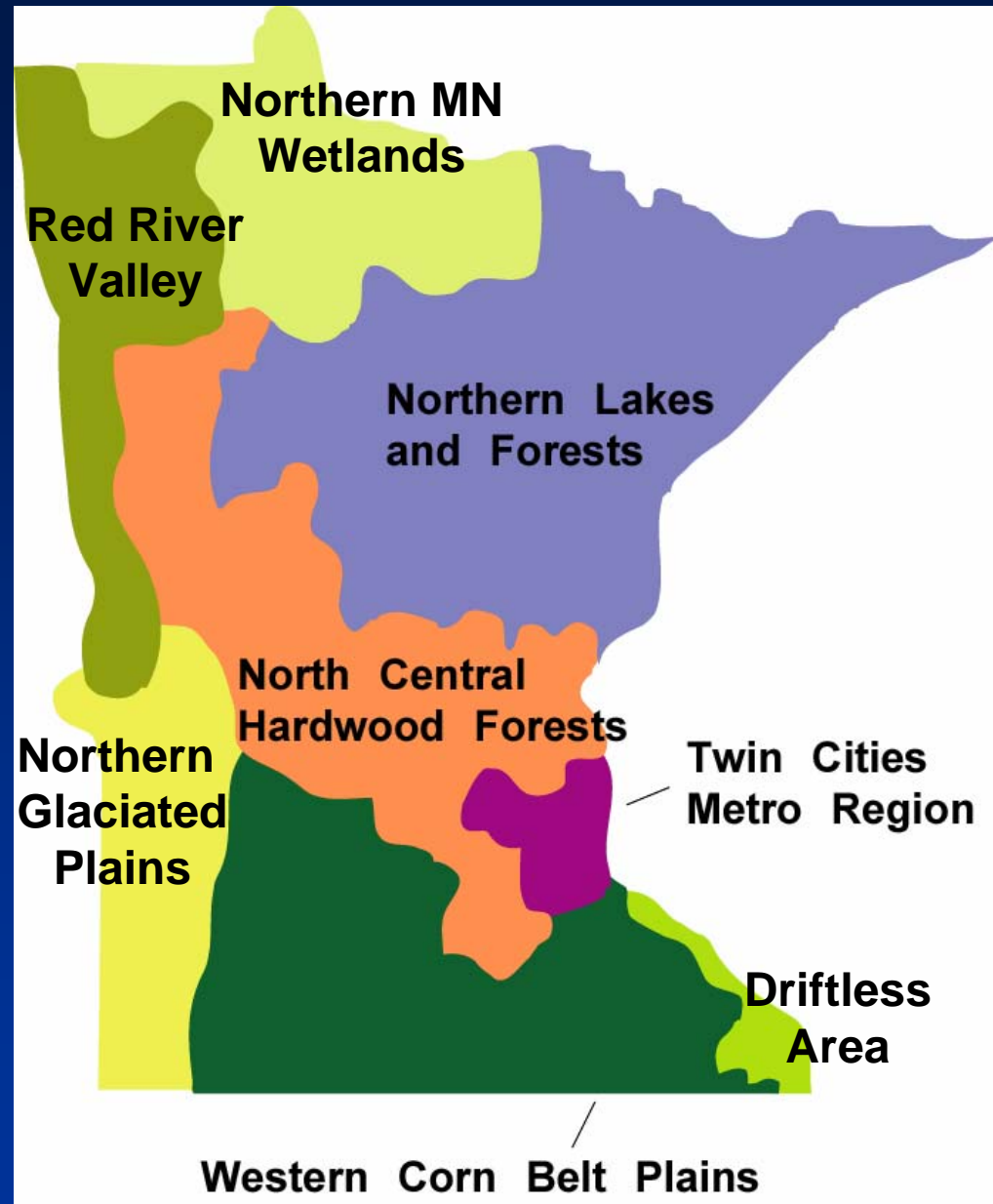
Paul Garrison
Wisconsin DNR

Shoreline Development



Paleoecology and Diatoms in Minnesota

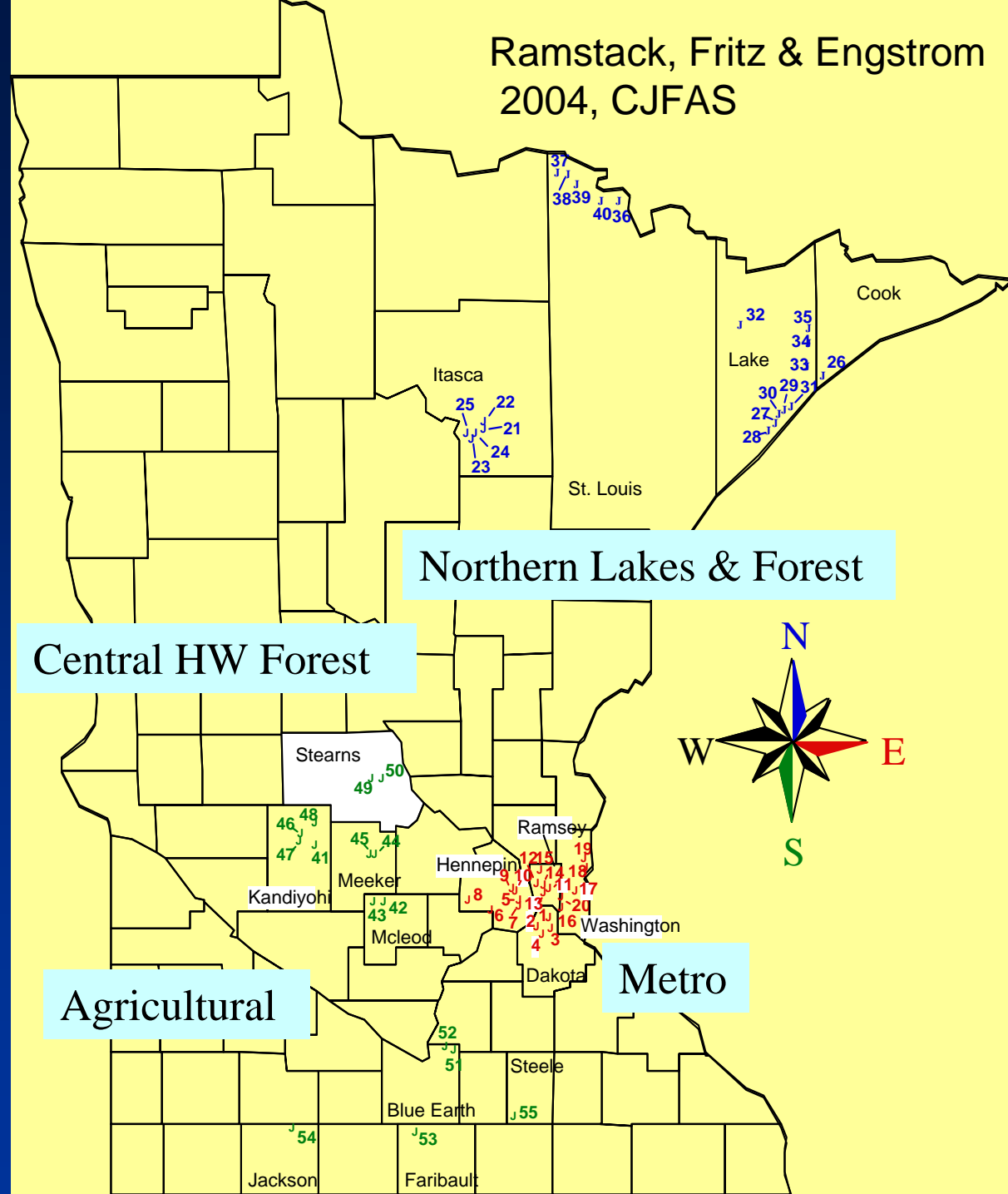
1. How have MN lakes changed - a statewide survey
2. Reference conditions and nutrient criteria - linking federal mandate to state policy



MN Study 1.

How have Minnesota lakes changed?

- 55 Minnesota lakes sampled (NLF, CHF, NGP, and WCBP ecoregions, & Metro area)
- 210-Pb dated sediment cores from 55 lakes
- surface sediments used in development of diatom-inference model
- diatoms studied in core samples from 1990, 1970, 1800, 1750
- looked at change in lakes between 1970 and 1990 (post Clean Water Act)
- looked at magnitude of change between pre-European water quality and 1990



Change from 1800 to the Present

Cl (mg/l)

Color (Pt-Co)

TP (mg/l)

-100 0 100 200

-40 0 40 80 120

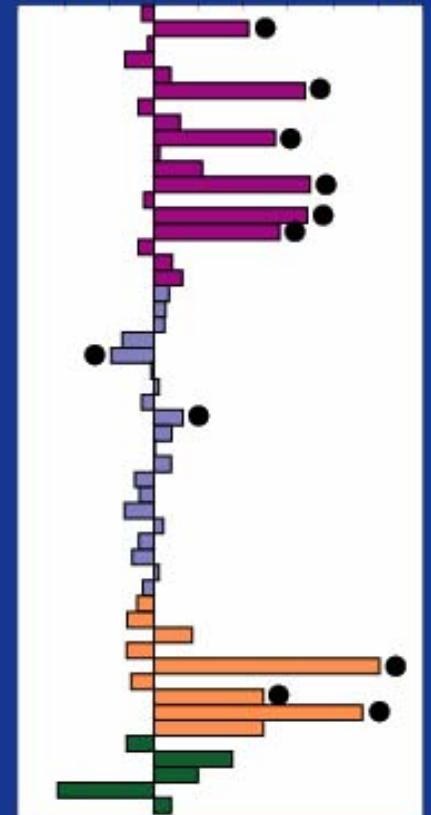
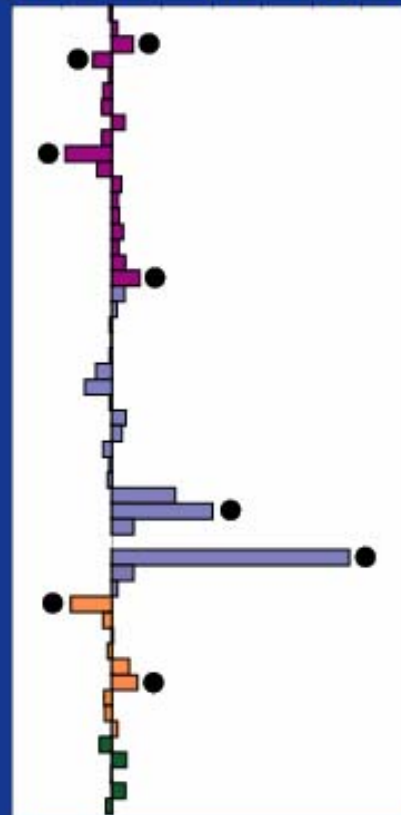
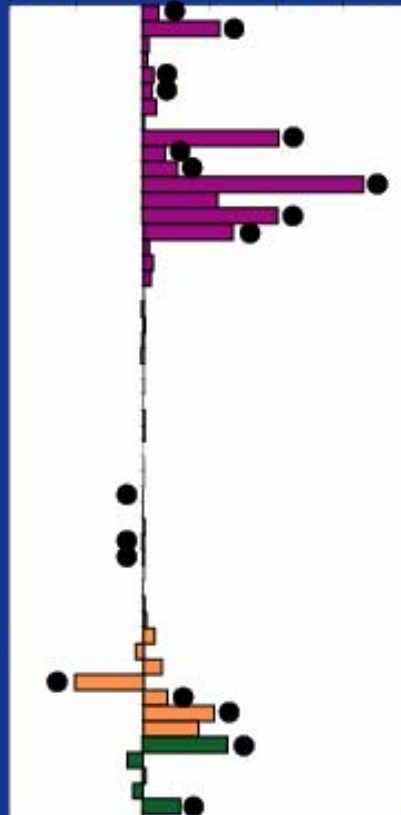
-0.02 0 0.02 0.06

Twin Cities
Metro Region

Northern Lakes
and Forests

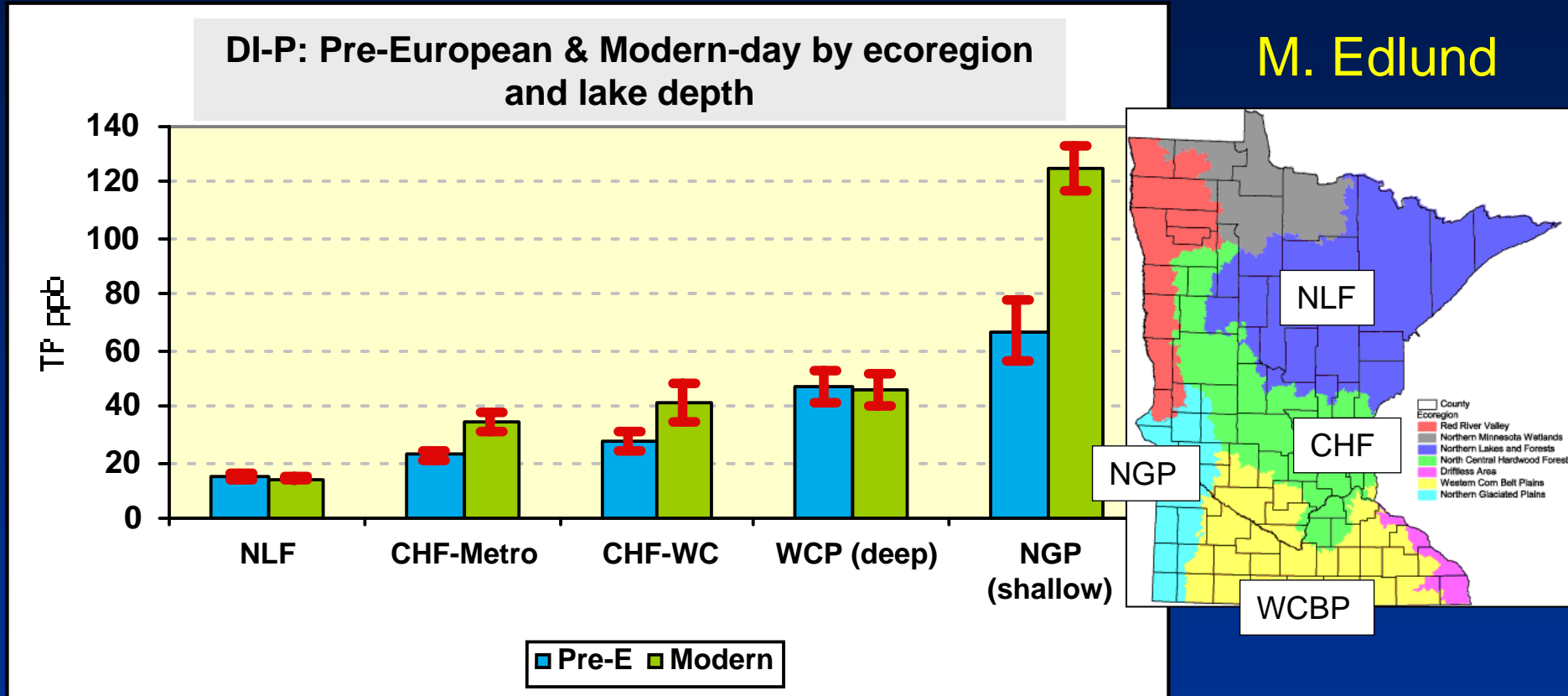
North Central
Hardwood Forests

Western Corn
Belt Plains



Pre-European TP vs modern water quality by MN ecoregion

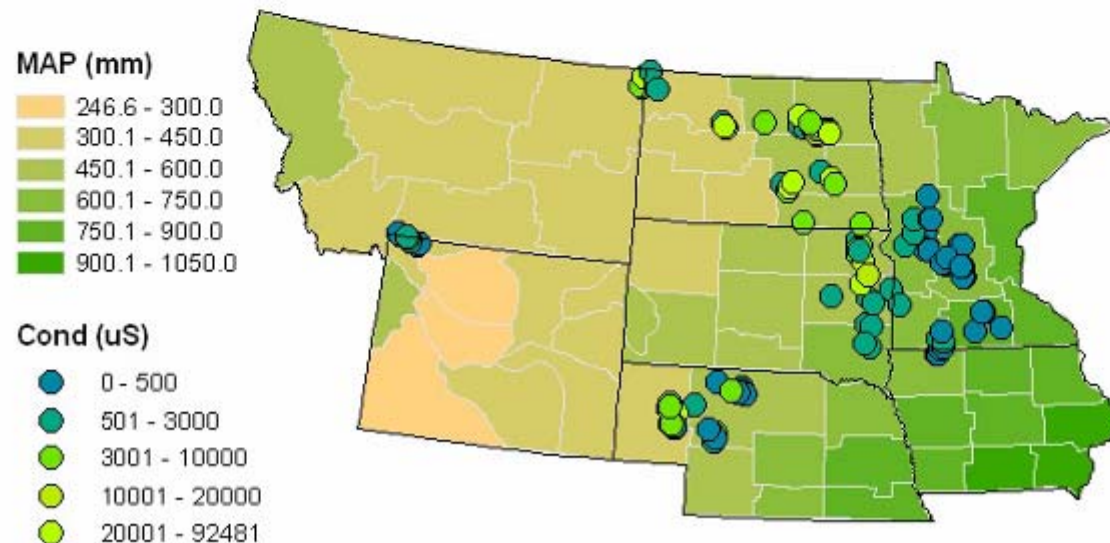
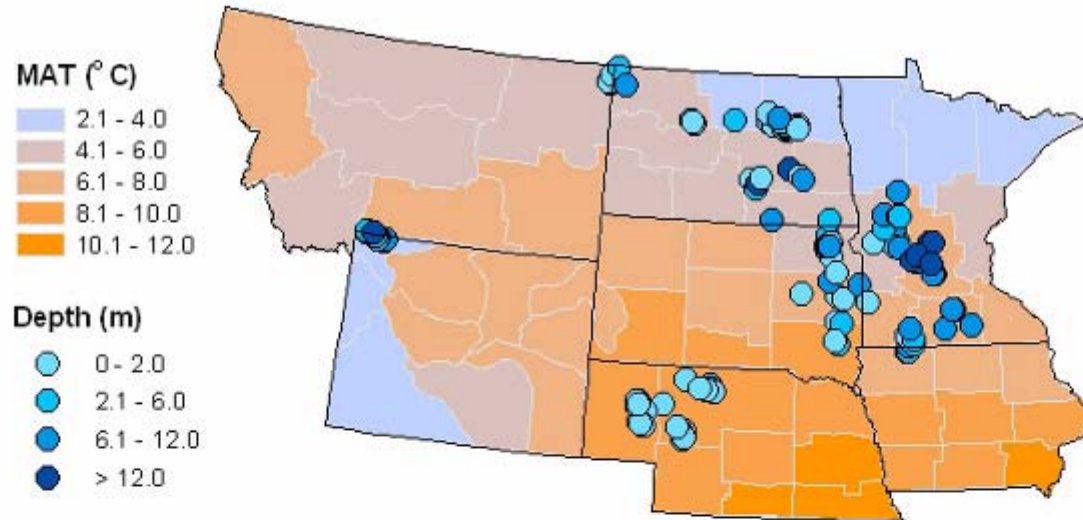
M. Edlund



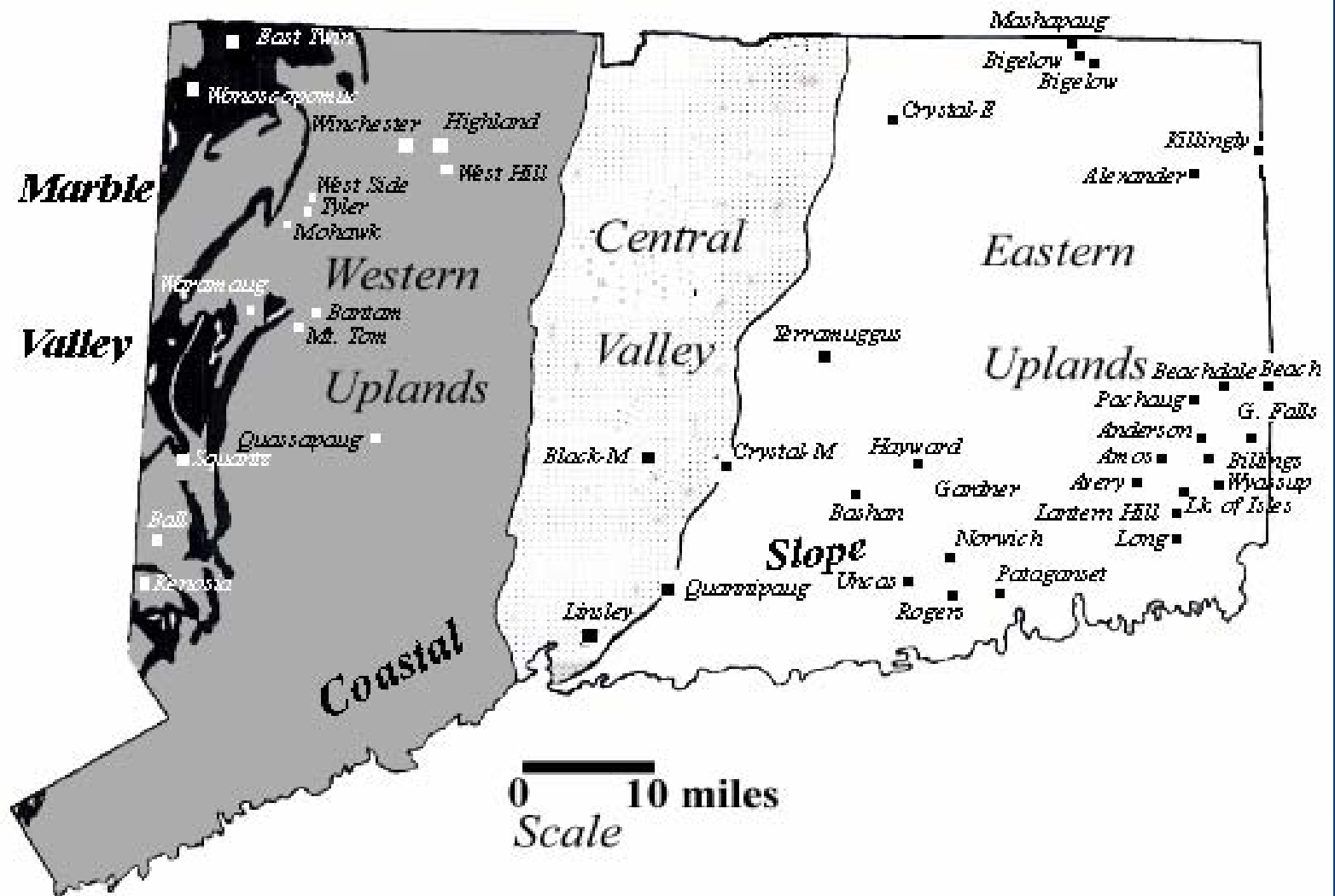
- 61 sediment cores from throughout Minnesota
- ecoregional patterns evident in Pre-European as well as modern-day TP
- NLF lakes minimally impacted, CHF lakes with elevated modern TP levels
- significantly different response between shallow and deep prairie lakes

S. Fritz

124 natural
lakes in
grassland
dominated
landscapes



Also are 30
Nebraska
Reservoirs &
sand pits
(not shown)

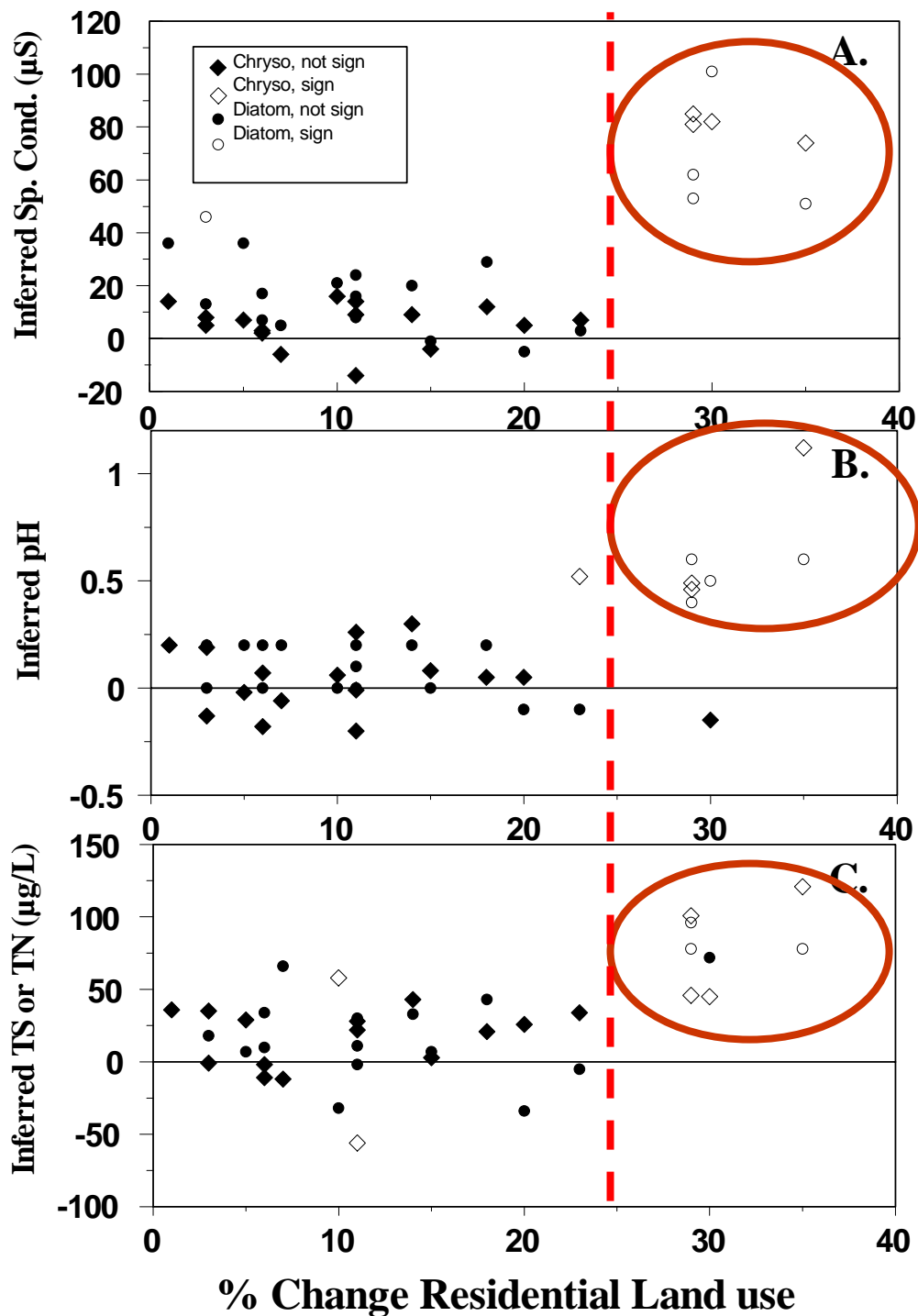


23 CT Lakes

Paleo Inferred change

Pete Siver
Conn. College
L&O, 1999

Change In



Cond.

pH

TN

% Land-Use
Change



Other Examples – Diatom Paleo Studies

- New England – P. Siver, D. Koster, R. Davis
- Wisconsin – P. Garrison
- MI – J. Stevenson et al.
- MN – S. Fritz, J. Ramstack, M. Edlund, R. Brugam
- Great Plains - S. Fritz
- MT – L. Bahls, ANSP
- Rocky Mtns. –A. Wolfe, J Saros, D. Beeson
- Pacific NW – Y. Pan, J. Eilers, J. Ford, C. Wielhofer
- FL & SE – T. Whitmore, E. Geiser

- European Diatom Database Initiative (EDDI)

Recommended Approach

- Analyze diatoms in top and bottom of sediment cores
- Use models based on existing and new calibration sets to infer at least TP, TN, conductivity, and pH; compare T&B species
- Calculate differences between current values and past (reference condition)
- Quantify condition; make population projections

Additional Optional Approaches

- Compare diatom-inferred reference conditions with reference-lake conditions
- Use paleo data to evaluate model hindcasts
- Examine multi-level stratigraphic trends in ^{210}Pb dated cores
- Analyze surface sediments only, if problems with lower intervals; analyze periphyton
- Analyze two samples from near bottom; use to calculate natural variability

Coring issues

- Equipment
- Field logistics
- Training
- Reservoirs

Glew Sediment Corer operation



From PEARL Website, Queen's Univ.



From PEARL Website, Queen's Univ.
Brian Cumming



From PEARL Website, Queen's Univ.



From PEARL Website, Queen's Univ.

Diatom Taxonomy / Inference Models

-- Issues for a National Lake Survey

- Need for consistent taxonomy
 - Common taxonomic list
 - Taxonomy workshops / documentation / images
- Use existing regional calibration sets; supplement with new data
- Make data available from Diatom Paleolimnology Data Cooperative
- Archive slides in museum collections

Conclusions

- Diatom / paleo approach may be best way to quantify lake health based on comparison of current and past (reference) conditions
- Methods tested and used widely; are effective
- Many existing calibration sets / models and experts
- Logistic requirements and costs reasonable

Acknowledgments

- Persons providing slides and helpful discussion: John Smol, Brian Cumming, Sushil Dixit, Mark Edlund, Sheri Fritz, Paul Garrison, Peter Siver